Chapter 2
Problem

2-1. Flooding in the United States

a. Flooding and flood-related events cause greater damage and more fatalities than any other natural disaster. About 80 percent of all presidential disaster declarations are the result of flooding (Federal Emergency Management Agency (FEMA) 1992a). Flood damages averaged $3.3 billion and flood-related fatalities averaged about 100 annually over the past 10 years (USACE 1993, 1994). The most common type of flood occurs as a result of a major rainfall or snowmelt. A second type of flood occurs suddenly, as in the case of dam failures or intense rainfall that generates a flash flood. A third category of flood results from an ice or debris jam. Flood stages during an ice jam (Figure 2-1) can increase more rapidly and attain higher levels than those associated with open water conditions. Ice jam flooding may occur outside the regulatory floodplain, often when the river flow would not otherwise cause problems.

b. Many laws and regulations have been developed to reduce national vulnerability to flooding. Most American communities have floodplain regulations designed to prevent future development in areas subject to conventional open water flooding. Some communities are protected by structural controls such as dikes, levees, and flood control dams. Mitigation measures specifically designed to protect against ice jam flooding are used less commonly.

2-2. Ice Jam Flooding

a. In many northern regions ice covers the rivers and lakes annually. The annual freezeup and breakup commonly occur without major flooding. However, some communities face serious ice jam threats every year, while others experience ice-jam-induced flooding at random intervals. The former often have developed emergency plans to deal with ice jam problems, but the latter are often ill-prepared to cope with a jam event when it occurs.

b. Ice jams take place in 30 states, primarily in the northern tier of the United States (Figure 2-2). Even mountainous regions as far south as New Mexico and Arizona experience river ice. Ice jams affect the major navigable inland waterways of the United States including the Great Lakes. A study conducted in Maine, New Hampshire, and Vermont identified over 200 small towns and cities that reported ice jam flooding over a 10-year period (USACE 1980). In March 1992 alone, 62 towns in New Hampshire and Vermont reported ice jam flooding problems after two rainfall events. Table 2-1 lists some of the major ice jams recently recorded.

c. In a l992 survey, USACE offices reported ice jam problems within 36 states. Of the 36 states, 63 percent reported that ice jams occur frequently, and 75 percent rated ice jams as being serious to very serious (White 1992).

d. Because ice jam events are less common and more poorly documented than open water events, it is more difficult to characterize these events than open water flooding. In addition, due to the complex processes involved in the formation and progression of ice jams and the highly site-specific nature of these jams, these events are more difficult to predict than open water flooding.

e. The rates of water level rise can vary from feet per minute to feet per hour during ice jam flooding. In some instances, communities have many hours of lead time between the time an ice jam forms and the start of flooding. In other cases, the lead time is a little as one hour. For example, in March 1992, an ice jam developed at 7:00 a.m. in Montpelier, VT. By 8:00 a.m. the downtown area was flooded (Figure 2-3). During the next 11 hours, the business district was covered with an average of 1.2 to 1.5 m (4 to 5 ft) of water. The event occurred so quickly that there was not sufficient time to warn residents so they could protect their goods. Even after water levels dropped, damage related to the flooding continued as cold temperatures caused freezeup of wet objects. Damages of less than one day were estimated at $5 million (FEMA 1992b).

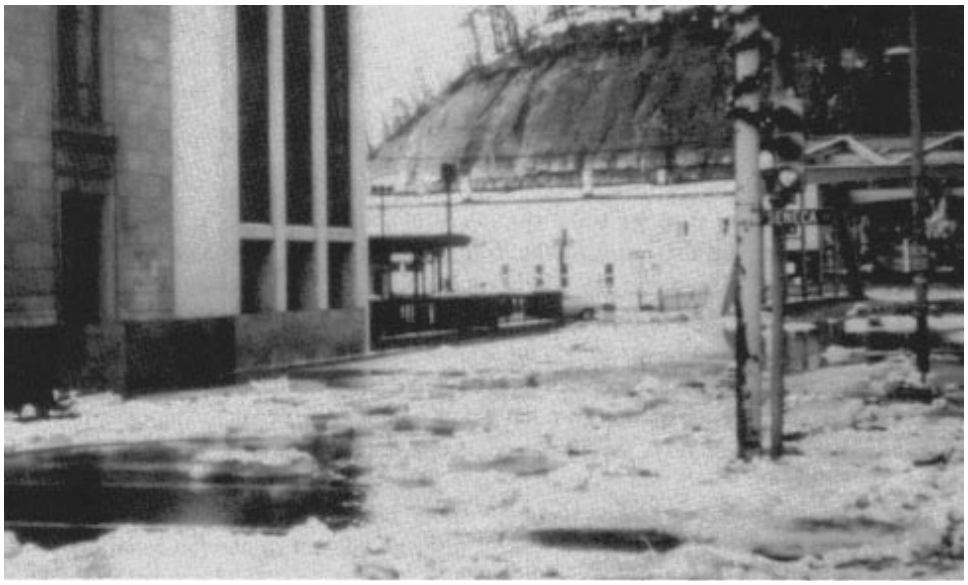

Figure 2-1. Ice jam flooding

f. Although the actual time period of flooding may be short compared to open water flood events lasting days to weeks, significant damage can result. The winter weather conditions often prevalent when ice jams occur also add to the risks and damages associated with ice jam flooding.

2-3. Ice Jam Flood Losses

a. Ice jam flooding is responsible for loss of life, although the number of fatalities in the United States is considerably less than non-ice jam flooding. In the last 30 years at least seven people have died as a result of ice jam flooding. Six of the deaths were attributed to rescue attempts; the other death occurred from injuries sustained when a basement wall collapsed due to pressure from flood waters and ice.

b. Ice jams in the United States cause approximately $125 million in damages annually, including an estimated $50 million in personal property damage and $25 million in operation and maintenance costs to USACE navigation, flood control, and channel stabilization structures.

c. Ice jams suspended or delayed commercial navigation causing adverse economic impacts (Figure 2-4). Although navigational delays are commonly short, they may result in shortages of critical supplies, such as coal and industrial feedstocks and large costs from the operation of idle vessels (USACE 1981). Ice jams sometimes cause damage to navigation lock gates. For more detailed information on the effects ice jams have on navigation and the range of strategies to mitigate the effects, see “Winter Navigation on Inland Waterways” (USACE 1990).

d. Ice jams also affect hydropower operations, causing suspension of hydropower generation due to intake blockage, high tailwater, the necessity to reduce discharge, or damage to intake works (Figure 2-5). Lost power revenue due to such shutdowns can be substantial.

e. The presence of an ice jam can result in scouring and river bed and bank erosion that may lead to bridge or river bank failure (Figure 2-6). Ice jams can damage stream channels and improvements so that overall vulnerability to flooding is increased. Riprap can be undermined or moved out of place. Ice-jam-related damage to river training structures costs millions of dollars each year.

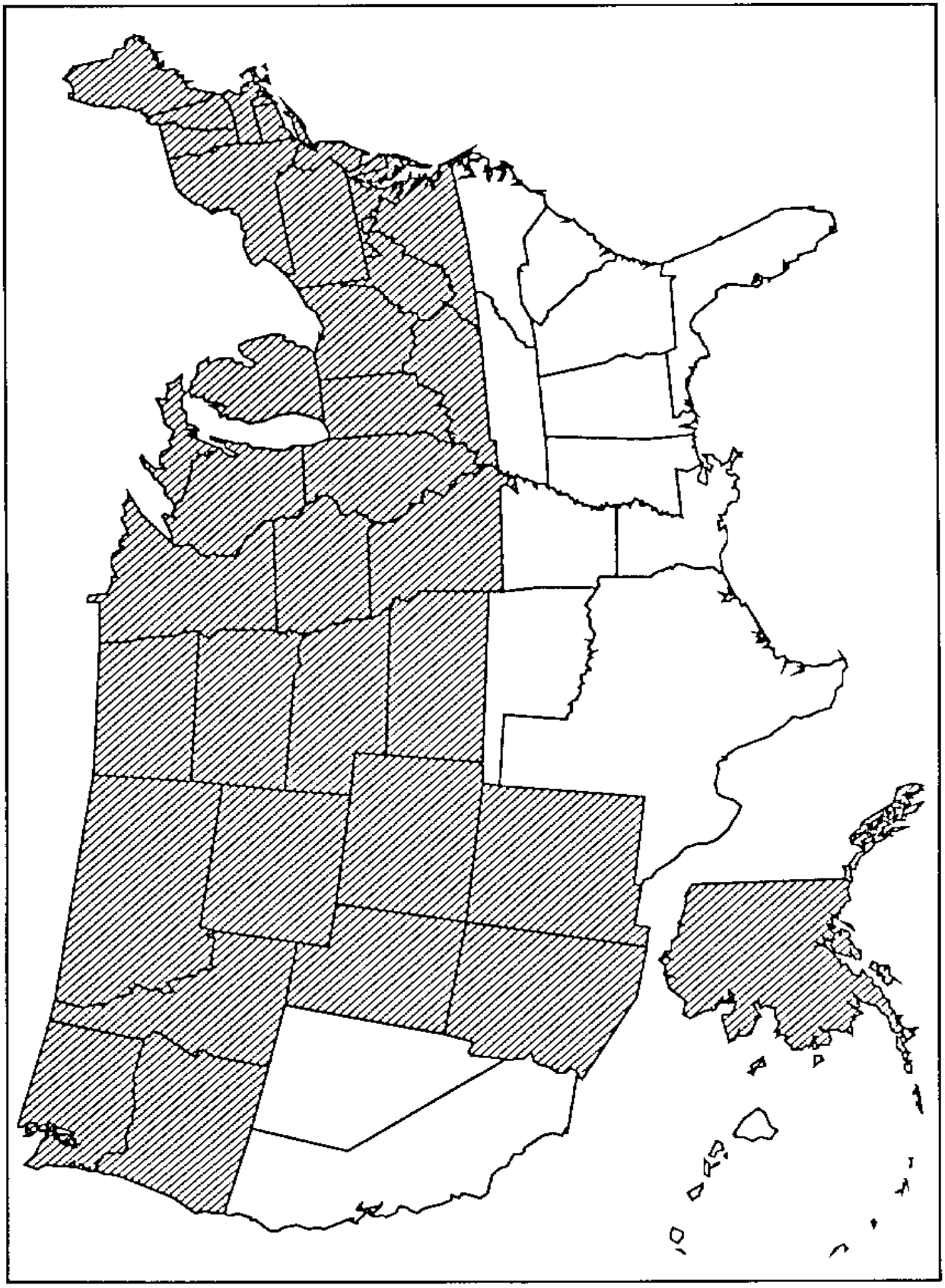

Figure 2-2. Ice jam flooding occurs in shaded states

Table 2-1
Recent Major Ice Jams in the United States

Place	Date	Type (Damages)
Montpelier, VT	March 1992	Breakup ($5M)
Allagash, ME	April 1991	Breakup ($14M)
Salmon, ID	February 1984	Freezeup ($1.8M)
Port Jervis, NY Matamoras, PA	February 1981	Breakup ($14.5M)
Mississippi/Missouri Rivers confluence	December 1989	Breakup (>$20M)

f. Indirect costs associated with ice jams include loss of fish and wildlife and their habitat. Scour and erosion associated with ice jams may destroy habitat, such as eagle roosting trees, and mobilize toxic materials buried in sediment. Some scouring may, however, be beneficial to wildlife habitat as well. Shallow, vegetation-choked wetlands may become open, allowing for fish and waterfowl spawning and brood habitat.

a. Winooski River

b. Downtown area

Figure 2-3. Views of Montpelier, VT, ice jam (March 1992)

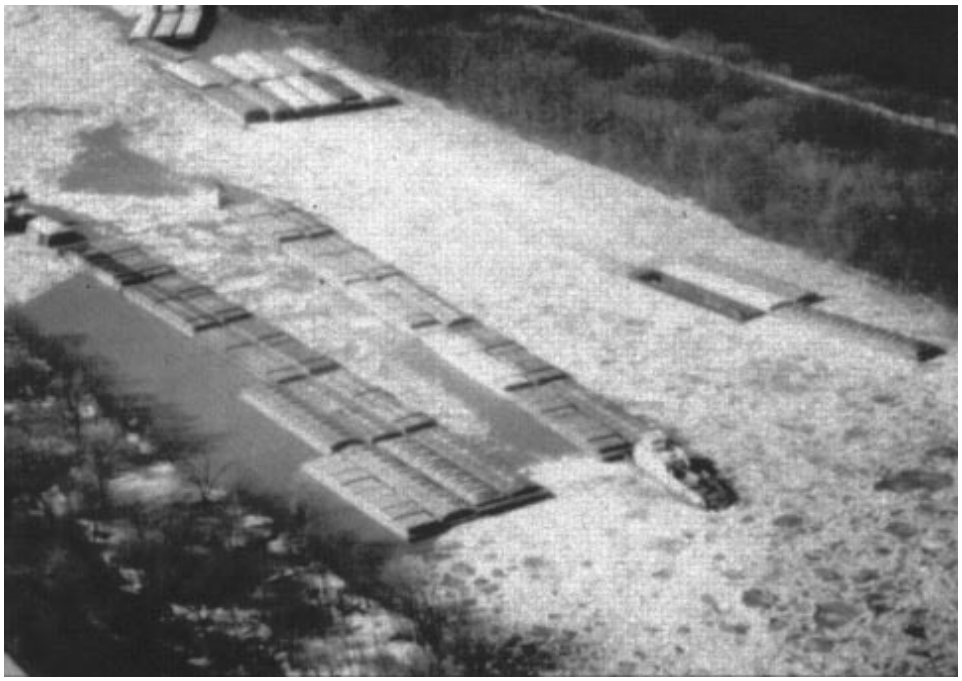

Figure 2-4. Towboats and barges in ice

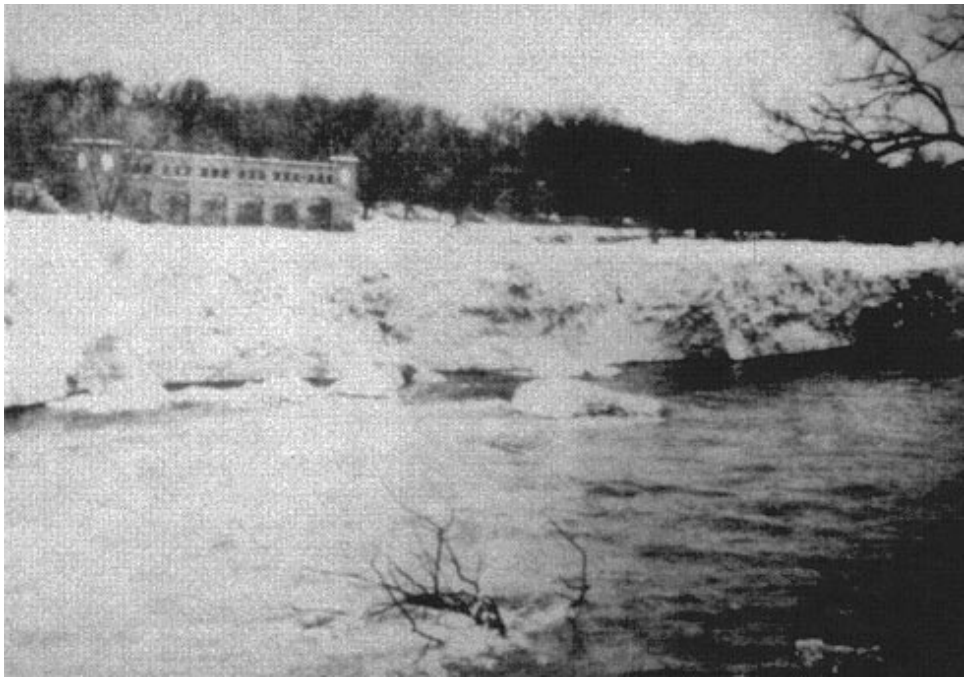

Figure 2-5. Jam immediately downstream of power plant, Fox River, IL

Figure 2-6. Bank scour due to a breakup jam, St. John River, MN, near Allagash